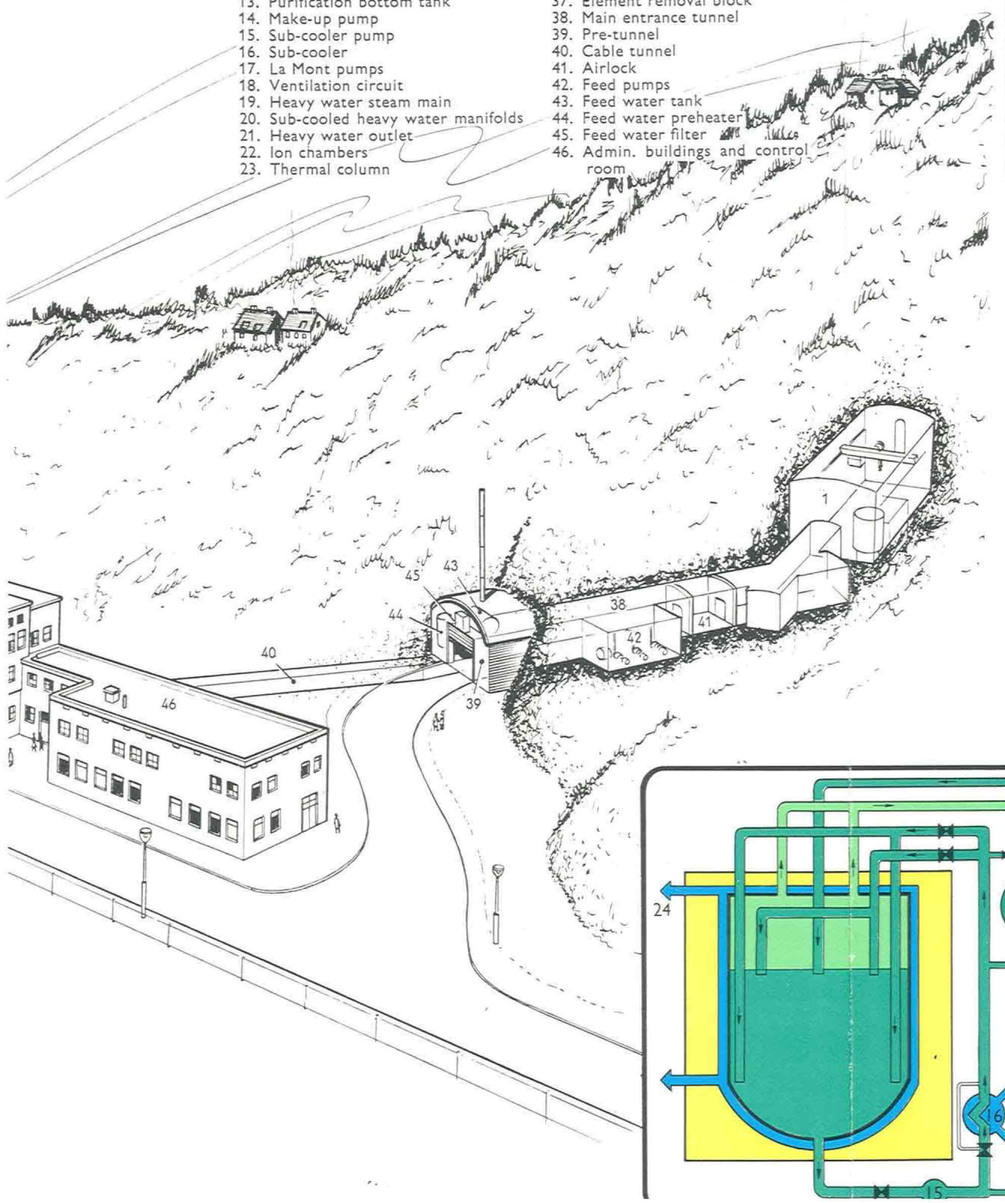
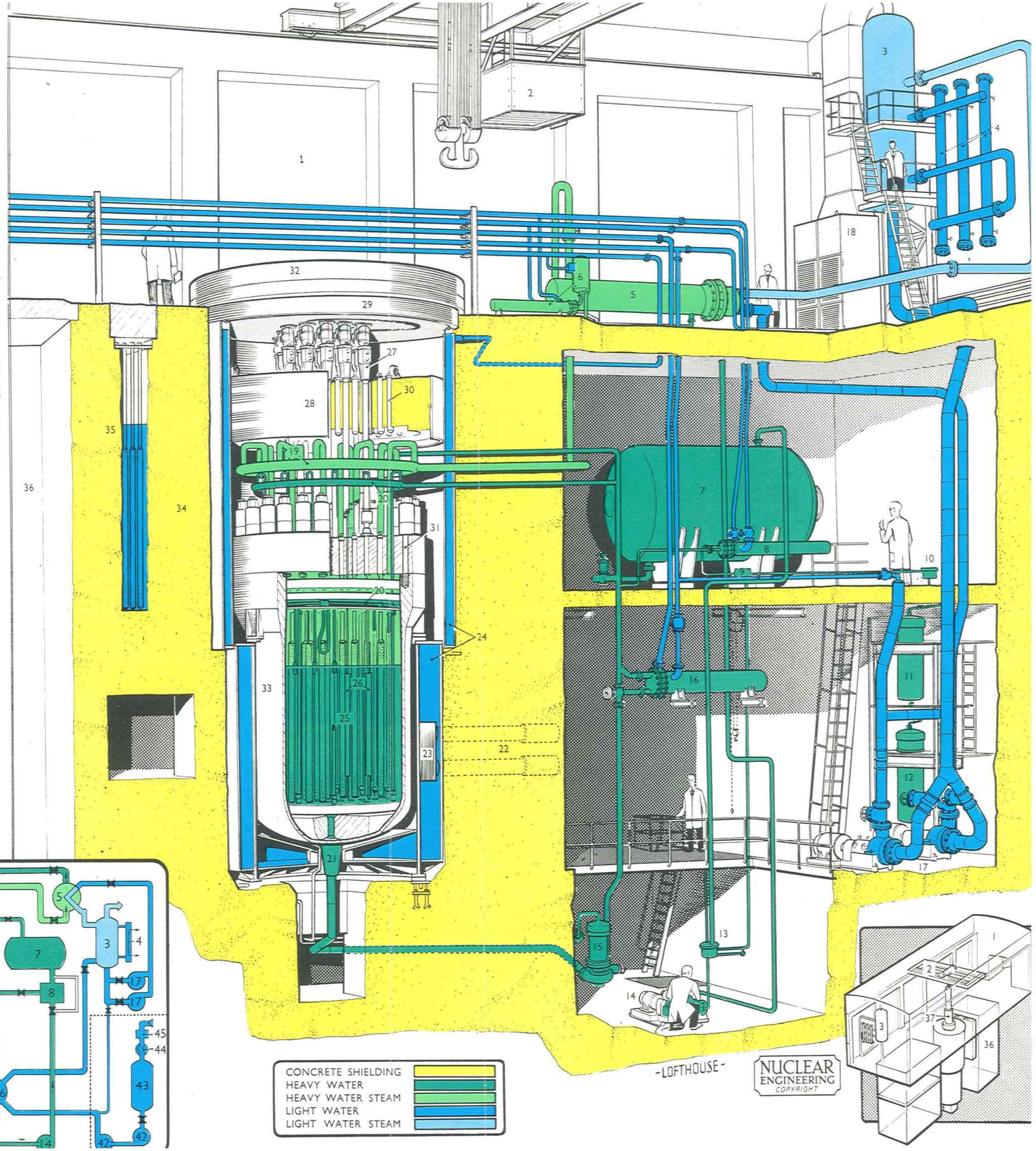
The World's Reactors

No. 21 HALDEN

KEY

1. Reactor hall (unmanned during operation)
2. Travelling crane
3. Steam drum
4. Electric heaters
5. Heat exchanger
6. Recombination units
7. Heavy water storage tank
8. Heavy water purification cooler
9. Filter box
10. Purification top tank
11. Cation exchanger
12. Anion exchanger
13. Purification bottom tank
14. Make-up pump
15. Sub-cooler pump
16. Sub-cooler
17. La Mont pumps
18. Ventilation circuit
19. Heavy water steam main
20. Sub-cooled heavy water manifolds
21. Heavy water outlet
22. Ion chambers
23. Thermal column
24. Shield coolant circuit
25. Core
26. Control rods
27. Control rod drives
28. Top shield
29. Access plates
30. Plugs
31. Hold down bolts
32. Cover plate
33. Reactor vessel
34. Main shield
35. Element storage pit
36. Reactor storage pit
37. Element removal block
38. Main entrance tunnel
39. Pre-tunnel
40. Cable tunnel
41. Airlock
42. Feed pumps
43. Feed water tank
44. Feed water preheater
45. Feed water filter
46. Admin. buildings and control room





CONCRETE SHIELDING
HEAVY WATER
HEAVY WATER STEAM
LIGHT WATER
LIGHT WATER STEAM

-LOFTHOUSE-

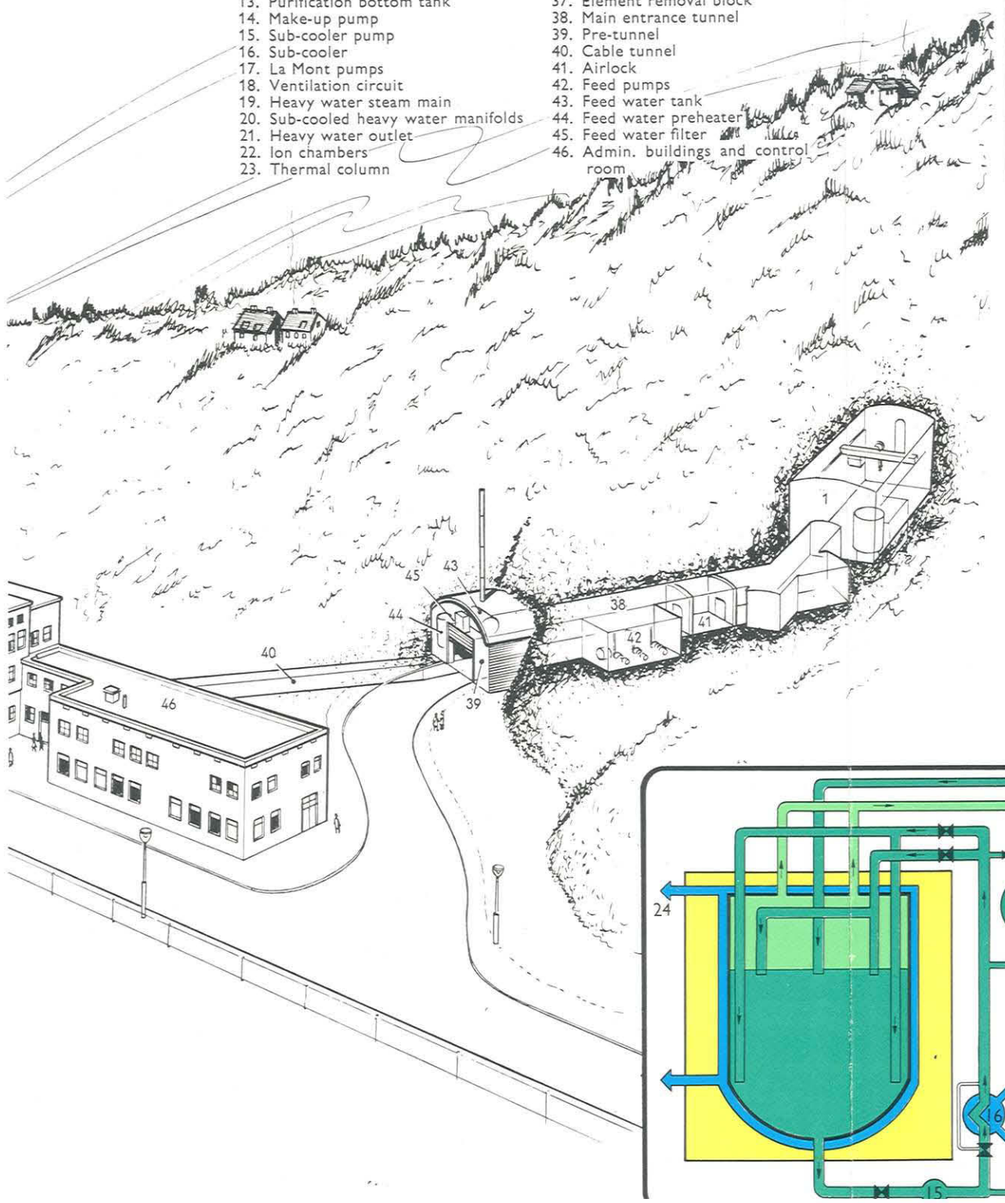
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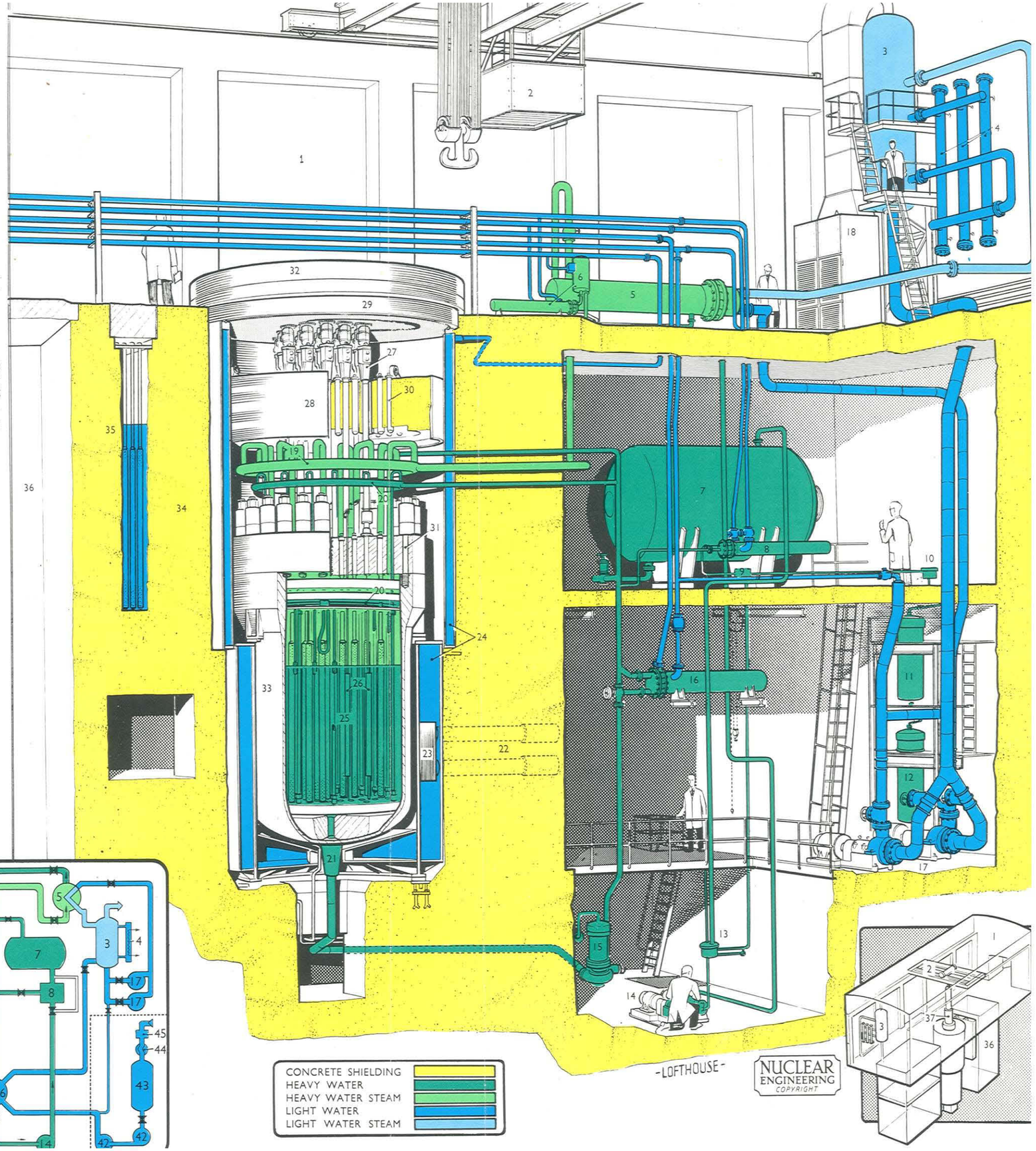
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CONCRETE SHIELDING
HEAVY WATER
HEAVY WATER STEAM
LIGHT WATER
LIGHT WATER STEAM

-LOFTHOUSE-

NUCLEAR ENGINEERING
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The World's Reactors

No. 21 HALDEN

TYPE: Thermal heterogeneous (boiling heavy water).

PURPOSE: Mainly experimental; some process steam production at later date.

LOCATION: Halden, S. E. Norway.

OWNER: Institutt for Atomenergi.

OPERATION: Criticality scheduled: March, 1959.

RATING:
5 MW, with first core.
10 MW, with second core; 20 MW at later date.

FUEL ELEMENTS:
First core: Natural uranium cylindrical rods, Al clad.
Spiked by s.s. clad, UO_2 rod clusters.
Rod diameter: 25 mm.
Rod length: 2.4 m U; overall 4.9 m.
Cladding: finned tube, 2 mm wall.
Total number of rods: 316.
Second core: enriched UO_2, s.s. clad.

CORE:
Hexagonal lattice, 130 mm pitch.
Provision for 325 elements.

MODERATOR COOLANT:
Heavy water.
Investment: 16 tonnes; 15 tonnes in core tank.
D_2O boils in core, latent heat removed in heat exchanger.
Up to 15% can be withdrawn from tank bottom.
Following figures refer to rating of 10 MW:
Operating pressure: 28 kg/cm² (400 p.s.i.).
Outlet temperature (steam): 230°C.
Inlet temperature (condensate): 220°C.
Steam loop circulation: 20 tonnes/h (74 gal/min).
Subcooled D_2O temperature: 200°C.
Subcooled D_2O flow: 80 m³/h (294 gal/min).

SECONDARY COOLANT:
Light water.
Temperature: 185°C.
Pressure: 17.5 kg/cm² (250 p.s.i.).
Steam output: 15 tonnes/h.
Main heat exchanger surface: 133 m².
Sub-cooler surface: 8.5 m².

FLUX: Thermal peak: 3×10^{13} n/cm², sec.

CONTROL:
19 shim/scram, 1 fine control.
Construction: cadmium tubes, s.s. clad.
Dimensions: 1800 mm × 51 mm o.d.
Reactivity controlled: 1.5% $\Delta k/k$, each shim/scram;
0.3% $\Delta k/k$, fine.
Drives: shim/scram: 2 speed, 3 ph, induction motors;
rod speed 12.5, 1.5 mm/sec;
fine: 2 ph induction motor;
rod speed: 0–25 mm/sec.

CONTROL REQUIREMENTS:

Xe and Sa	3% $\Delta k/k$
Temp. compensation	8% $\Delta k/k$
Voids	1% $\Delta k/k$
Operation and burn-up	2% $\Delta k/k$
Total	14% $\Delta k/k$

REACTOR TANK:
Vessel: s.s. clad plate.
Dimensions: 475 cm high (less closure) × 270 cm i.d., 6 cm wall.
Cladding: 5 cm thick.
Closure: 343 cm × 70 cm thick.
Design pressure: 40 kg/cm² (570 p.s.i.).
Test pressure: 56 kg/cm² (800 p.s.i.).

SHIELDING:
Side thermal: 37 cm water.
Side biological: 235 cm concrete.
Top: 82 cm concrete in iron.
Cover plates: 23 cm steel.

REACTOR HALL:
Dimensions: 28 m × 10 m × 11.4 m high.
Entrance tunnel: 60 m.
Total rock removed: 8,000 m³.

Data sheets in this series already published in "Nuclear Engineering" are:

No. 1. BEPO (April, 1956)
No. 2. CP5 (May, 1956)
No. 3. NRX (June, 1956)
No. 4. DIMPLE (August, 1956)
No. 5. ZEUS (September, 1956)
No. 6. CALDER HALL (October and December, 1956)
No. 7. RUSSIAN 5 MW (November, 1956)
No. 8. DIDO (January, 1957)
No. 9. THE SOUTH OF SCOTLAND ELECTRICITY BOARD STATION (February, 1957)
No. 10. BERKELEY POWER STATION (March, 1957)
No. 11. BRADWELL POWER STATION (April, 1957)
No. 12. DOUNREAY FAST REACTOR (June, 1957)
No. 13. EBWR (July, 1957)
No. 14. RWE 1 (September, 1957)
No. 15. LIDO (November, 1957)
No. 16. PLUTO (April, 1958)
No. 17. MERLIN (May, 1958)
No. 18. G1 (June, 1958)
No. 19. HINKLEY POINT POWER STATION (July, 1958)
No. 20. NRU (February, 1959)